PRIMARY RESOURCE INDUSTRY WASTE ON PRINCE EDWARD ISLAND

By J.A. Cousins

SPONSORED BY THE PEI DEPARTMENT OF FISHERIES AND ENVIRONMENT AND BY ENTERPRISE PEI SEPTEMBER 1997

I INTRODUCTION

NATURAL RESOURCES AND THE PRINCE EDWARD ISLAND ECONOMY

The economy of Prince Edward Island is substantially based on natural resource industries, primarily agriculture and fisheries. The "Million Acre Farm" produces more potatoes than any other province, and sits in rich lobster fishing grounds. Despite the gradual disappearance of the mixed farm, the Island continues to support a mixed agricultural sector, with beef, dairy, and hog sectors in addition to the famous potato industry. The value of the island fishery has actually increased in the years of the ground fishery collapse; the lobster fishery is complemented by other shell fisheries and a considerable aquaculture sector. Finally, the relatively small forestry sector is growing quickly.

Primary industries and food processing constituted 24 percent of the Prince Edward Island economy in 1995, and 31 percent of the business sector. Processed food products made up a significant part of Prince Edward Island's international (39 percent) and interprovincial (23 percent) trade. The primary resource sector is a net *exporter* in a province that is a net *importer*.[(1)] In 1995, Prince Edward Island exports went to about 28 countries and were valued at $117 million. Agri-food related products and services amounted to 85 percent of this total.[(2)]

APPROACHES TO WASTE

A notable feature of primary industries is the amount of waste and by-product they generate. On Prince Edward Island, for example, the potato industry each year produces well over two million hundredweights of culls and rejects -- over 12 percent of total production, and sometimes over 20 percent. Potato processors generate their own waste in the form of peels and rejects. Livestock farms produce great quantities of manure, while lobster processors discard over 2000 tons of shells each year.

Waste and by-products can be viewed in two ways -- as a loss and a nuisance, or as an opportunity. Much of the waste that currently represents dead financial loss to producers could be either reduced or better utilised through various techniques to "add value."

The objectives of this report are:

- to describe, in a broad way, the systems by which waste is presently disposed of;

- to suggest areas where there might be potential for more financially profitable utilisation of wastes which are now un- or underutilised;
- to discuss the idea of a facilitating structure to investigate and market potential applications for primary sector waste and other underutilised resources. Such a structure would participate in research and development, as well as attempt to create connections with other jurisdictions facing similar problems with resources and waste (e.g. among the participants in the North Atlantic Islands Programme).
- to present an annotated bibliography of material related to waste management and value enhancement, particularly in primary resource industries.

This report deals specifically with the primary resource industries, particularly fisheries and agriculture. Domestic waste management is an important issue on Prince Edward Island, as it is in any small jurisdiction with limited space for disposal. This problem is being addressed most significantly by the extension of the Waste Watch system over the whole of the province. The problem of domestic waste management will be addressed in this report, but more selectively than issues related to the primary resource industries.

II CURRENT SYSTEMS : AGRICULTURE

The mixed resource economy on Prince Edward Island has traditionally facilitated a system of waste disposal that saw the majority of waste utilised, but to little or no economic effect. Lobster shells, for instance, have been spread on farmland as a soil amendment, while culled potatoes are fed to cattle on the producers' own, or a neighbour's, farm. Animal manure, of course, usually goes straight back to the land.

This system has contributed to the success of the mixed farm, and now the mixed agricultural industry, on the Island. However, waste still represents lost economic opportunity to producers. In addition, the decline of the mixed farm in favour of larger, specialised farms has added complications to the task of waste disposal and utilisation.

POTATO CULLAGE

A substantial portion of the potato crop proves unusable for seed, table stock, or processing. "Cullage and Loss" amounted to almost four million hundredweights in 1995, from a total crop of about 28.2 million hundredweights -- a rate of about 13.5 percent. Cullage varies from year to year, depending upon a number of influences, including:

North American price and demand;

- weather during the growing season; and
- pest and disease problems.[3]

Between 1978 and 1995, cullage rates in the Prince Edward Island potato industry ranged from 12 percent to 31 percent of total production.[4] A Royal Commission on the Prince Edward Island Potato Industry concluded that cullage was higher than in other potato-growing regions partly because of a lack of processing alternatives beyond the french fry market.[5]Of course, in the subsequent decade the processing industry has expanded, but

so has potato production. Cullage rates have not changed drastically since the Royal Commission Report or since Morley Pinsent's *Inventory of Usable Waste Products for Prince Edward Island Farms* was prepared; there has been a general decline, but it has been interspersed with "spike" years in which cullage rises or falls by 5 percent or more. (See Table 1)

THE BEEF-POTATO SYSTEM

The presence of a significant beef and dairy industry has made the disposal of potato cullage quite easy; potatoes which are edible (but culled for reason of size, shape, etc.) are supplied to cattle feeding operations. In some cases, potato producers keep their own cattle; more often, culls are shipped to beef (and sometimes dairy) farms for a cost to the cattle farmer of little more than the price of shipping. Feed lots can account for a large portion of potato cullage in any given year -- by Pinsent's 1991 account, about one-fifth of all potato production. As he points out, this is a nearly perfect fit with a cullage rate averaging 17.6 percent between 1978 and 1990.[6]

TABLE 1

POTATO PRODUCTION AND CULLAGE, 1984-1995 [7]

YEAR	PRODUCTION (CWT)	CULLAGE/LOSS (CWT)	CULLAGE/LOSS (%)
1984	18629073	4435556	23.8
1985	17213883	3515502	20.4
1986	17592361	3675585	20.9
1987	15919210	3497104	22
1988	18083365	3471772	19.2
1989	18518320	2353102	12.7
1990	18650581	2947852	15.8
1991	18964950	2682692	14.1
1992	24600424	4692853	19.1
1993	22444915	3110521	13.9
1994	23412782	2990375	12.8
1995	28208723	3912038	13.9

For all its convenience, this system of cull disposal is an economic drain on potato producers, for whom cullage represents almost a dead loss. On the other hand, the supply of cull potatoes is one of the elements that makes the Island cattle sector a viable industry, particularly in view of high prices for other feed sources; in fact, the beef industry, valued at about $30 million and 15 percent of farm cash receipts, might not survive without the cull potato supply.[8]

This system is most effective in areas where there are mixed farms, or where beef and potato farms coexist. In some areas disposal becomes more difficult if the two types of farms are not located near each other (e.g. in parts of King's County). In New Brunswick the provincial

government deals with this problem by offering a "Cull Potato Livestock Feed Utilization Incentive." This program provides financial assistance for beef farmers who are not located in potato-growing areas to have cull potatoes shipped to their farms.[9]

BURIAL AND COMPOSTING

The majority of culled and graded out potatoes are fit for consumption, but are rejected on the basis of size, shape, malformation, or some other imperfection (aside from diseased tubers). In addition, the Department of Agriculture and Forestry offers potato growers financial assistance to bury or compost surplus potatoes, culls, and potato waste and debris. The government will provide up to $10 per ton, to a maximum of $600 per farm, for composting. If potatoes are buried, there is provision for up to 50 percent of approved costs to a maximum of $300.

The disposal of surplus potatoes falls under the authority of the *Plant Health Act*. Potatoes left undisposed present a risk of spreading disease of the current crop. There are fines and penalties of up to $1000 for anyone leaving potato waste or cull piles outdoors and uncovered after June 15.[10]

THE DEHYDRATION PLANT

The most significant new development for potato processing and the utilisation of graded-out and culled potatoes is the announcement in July, 1997, of the impending construction of a potato dehydration plant in Souris. The $30 million project has investors in Canada and the Netherlands, with assistance from the Atlantic Canada Opportunities Agency. It is expected to create about 119 full- and part-time jobs.

The plant will produce dehydrated potato granules. Market contracts have already been secured in Europe, Japan, and North America. The granules are used in producing baked low-fat potato chips, pasta, soup, and baby food, among other things. The plant will be the first of its kind in Atlantic Canada, and is expected to be operational by the summer of 1998.

Preliminary estimates suggest the plant will process about 150 million pounds (75,000 tonnes, or 1.5 million hundredweights) annually, a purchase of about $3.3 million of off-grade potatoes which have no other market.[11] The financial gain to producers may be marginal, on the order of 1 or 2 cents per pound for culls, perhaps slightly more for higher grade potatoes.[12]

The introduction of a "de-hyd" plant to utilise unmarketable potatoes is an encouraging step, and fits well with the widely held belief that Island table stock potatoes should be upgraded to higher quality by grading out marginal potatoes and creating a higher value "premium" product.[13] Such a process would result in higher percentages of waste potatoes. Dehydration is one application for such rejects; the Prince Edward Island Food Technology Centre has experimented with other products which can be produced from culls, such as refrigerated high value-added products.[14]

ANIMAL MANURE

The major by-product from livestock is manure. Manure's status as a cornerstone of traditional sustainable agriculture on Prince Edward Island is well documented.[15] The specialisation of contemporary farming means that it is not as simple to ensure that manure is applied to potato lands as was the case in the days of mixed farms (although the mixed farm has not altogether

died out).[16] Nevertheless, it seems that manure is still applied to the soil in huge amounts. Morley Pinsent estimated that approximately 1.5 million tons of animal manure are produced annually on Prince Edward Island, virtually all of which is reapplied to the land on the farm of origin or another near by. As he put it, "Most livestock production in the province is an integrated part of the whole farm operation with manure being considered as part of the fertility cycle."[17] Manure is seen less as waste material than as a resource.

There is, however, potential for a future problem in manure handling. The hog industry is growing quite rapidly, and, in keeping with the trend toward large, specialised farms, greater numbers of animals are concentrated on single farms. This expansion in hog farming has become a "hot button" issue, particularly around Ebenezer, where a proposed "factory hog farm" has drawn complaints about potential sewage odour and water pollution from sewage lagoons.

TABLE 2

HOG AND CATTLE POPULATION, 1984-1996 [16]

YEAR	HOGS	CATTLE
1984	122000	101000
1985	115000	100000
1986	117000	100500
1987	124000	99000
1988	124000	99000
1989	121000	98000
1990	109000	97000
1991	108000	95000
1992	103000	94000
1993	101000	94000
1994	112000	93500
1995	117000	94000
1996	117000	92500

The growing size of hog farms is evident from the declining number of registered producers -- from 1300 in 1980 to abut 400 in 1995.[19] Considered along with the rising (and forecast to continue rising) hog population, this means the animals are much more highly concentrated on fewer farms.

As livestock numbers grow, and mixed farms disappear, there will need to be some consideration of how best to handle the increased quantities of manure which must be transported or otherwise disposed. In fact, livestock operations are already a significant source of ground- and surface-water contamination from cattle near streams, land wash from pastures and feed lots, and ineffective manure storage facilities. There may be methods of safely treating excess manure --

for instance, the creation of artificial wetlands into which waste can be piped and stored.[20] It has been suggested that present legislation in this area -- the provincial *Environmental Protection Act* and *Forest Management Act*, and the federal *Fisheries Act* -- are not adequately enforced.[21] Proper storage and spreading practices are essential, to prevent water contamination and odour problems.[22]

COMPOST FROM WASTE ?

The most pertinent question with respect to manure, then, is how it can best be utilised in the manner in which it is already being applied, while avoiding problems resulting from manure accumulation in areas of intensive livestock production but less intensive crop production. For instance, would manure be effective as a compost ingredient, and might such a mixture be marketable? Composting would not necessarily add much value to manure[21], but it does seem to be a possible outlet for manure and other agricultural and fishery wastes. It has been suggested that compost has significant potential for agricultural land improvement, given assurance of the quality of the compost.[23] According to one source involved in marketing compost, there is little political/legislative or financial incentive for farmers to spread compost in view of the lower handling costs of commercial fertiliser.[25] However, the source separation plant in Wellington has been able to sell virtually all the compost it produces, mainly to farmers.[26]

Compost has demonstrated certain practical advantages over fertiliser, such as moisture retention.[27] According to a recent Agriculture Canada study, the addition of organic composted solid wastes to degraded soil could have such benefits as:

increased soil aggregation and porosity, improved soil water infiltration and retention, increased gas exchange and cation exchange capacity, improved root growth, and reduced wind and water erosion. Moreover, the restoration of soil quality will contribute to improve surface and groundwater quality and crop production. In addition to altering soil quality, CSSSW may be useful to resolve various agricultural problems. For example, agricultural wastes may be mixed with CSSSW and provide a material which is more useful than either alone. However, the CSSSW may need to be engineered to crop specific needs to avoid possible deleterious effects.[28]

From a marketing perspective, compost has proven appeal as a topsoil substitute and agent for renewing soil organic matter. There are also a number of niche markets which could be served by compost products (for instance, gourmet mushrooms can be grown in compost, as is already done on the Island).[29] Compost production can utilise a broad range of waste products from the primary resource industries, including forestry.[30]

FOOD PROCESSING

The potato processors are the largest industrial enterprises on Prince Edward Island; they directly utilise the products of the primary industries, and produce waste which is similar in nature. For instance, the french fry plants produce considerable amounts of waste peelings, culls, etc., on a daily basis; by one 1994 estimate, the New Annan plant, after expansion, could provide feed for over 5000 head of cattle each day.[31] Dairy processing also produces quantities of waste -- such as the whey which is dumped in Summerside harbour. With access to appropriate feeding systems, and combination with the right raw materials (e.g. fish waste), whey can serve as high-

protein swine feed.[32] Given the growth in the Prince Edward Island hog population in this decade, might the production of swine feed from agricultural and fishery wastes be feasible?

FORESTRY PRODUCT WASTE

The Prince Edward Island forest industry is by far the smallest of the primary resource industries, representing less than five percent of the sector. In recent years, though, it has grown more rapidly than the agriculture sector.[33] Wood ash can be used as a soil neutralising agent and fertiliser, and as an ingredient in compost, as can coarse sawdust (which is particularly useful as a bulking agent).[34] Sawdust can also be processed into pressboard.[35] While some sawdust is processed into compost at the East Prince site, more is accumulating; the utility of sawdust is somewhat dependent on its quality.[36]

THE ENVIRONMENTAL FARM PLAN INITIATIVE (EFP)

The EFP initiative, while not dealing primarily with waste management or economic development, is one of the more visible aspects of the drive to make Prince Edward Island (and Maritime/Canadian) agriculture more economically and environmentally sustainable. The EFP, launched by the Atlantic Farmers Council in partnership with governmental and industrial organizations, draws upon the willingness of individual farmers to identify and change aspects of their farm operations that pose environmental risks. The EFP initiative is not primarily aimed at market advantage, although this might be a side effect. There is evidence that "eco-labelled" products, if priced competitively, appeal to consumers.[36]

One element of the EFP review is a consideration of the management of farm wastes. Some initiatives have been taken by the government and the industry in this area. A good example is the Prince Edward Island Pesticide Container Recycling Program, which arranged the recycling of 70 percent of all pesticide containers sold in 1994.[38]

CONCLUSION

Agricultural waste utilisation on Prince Edward Island is quite comprehensive, but serves only a marginal economic purpose. The best that can be said is that the great majority of waste is used in some way that is quite valuable, even if no financial benefit accrues (e.g. manure spreading, cull potato supply to cattle feeding operations). Ideally, some or all of this waste could be turned into a source of greater revenue. As with any natural resource, yields are limited; Prince Edward Island cannot grow an infinite supply of potatoes. It is therefore necessary to extract the greatest possible value from what can be produced. Statistics Canada estimates that:

A $10 million increase in production in the agricultural sector would increase the GDP in P.E.I. by $6 million and Canada by $8.4 million.[39]

More effective waste utilisation could be one contributor to an increase in the value, as well as the sustainability, of the agricultural sector.

III CURRENT SYSTEMS : FISHERIES

The main effect of the collapse of the Maritime ground fishery on Prince Edward Island has been to increase the importance of shellfish and aquaculture. Shellfish values have steadily grown in

the 1990s, while the fin fishery has shrunk to less than 10 percent of fish and shellfish exports in 1995.[40] Aquaculture, primarily of mussels and oysters, accounts for over 10 percent of the value of the Prince Edward Island fishery.[41]

The Prince Edward Island fishery includes about 5200 fishermen and 65 processing plants.[42] The two main fishery waste disposal problems are lobster processing by-product and mussel waste.[43]

LOBSTER : INCREASING VALUE

The lobster industry is actively seeing ways to maximize production and improve quality. One element of this campaign is the minimization of waste by reducing the numbers of lobsters which die in shipment, and increasing product yield. For example:

> The Canadian Atlantic Lobster Promotion Association (CALPA) and the Atlantic Veterinary College (AVC)[44] began a three-year project in September, 1995, to study ways to maintain the health of lobsters in short- and long-term holding.[45]
>
> The P.E.I. Food Technology Centre, having developed a heat treatment process to kill the dangerous *Listeria monocytogenes* bacteria in processed lobster products, is working on a project to reduce shrinkage caused by the heat treatment (by adding the preservative Nisin). Shrinkage of packaged lobster may cause the loss of up to $2 million per year.[46]
>
> The Food Technology Centre has also developed a bar code labelling system to monitor the health of lobsters during transportation and holding; vacuum technology to recover hard-to-reach meat out of the shell; and improved preparation methods and potential value-added products for lobster by-products and underutilised species.[47] The Food Technology Centre is also researching the removal of tomalley before cooking as a method of extending lobster shelf life. Shipping mortality and loss now takes up to $75 million per year out of the Atlantic Canadian lobster industry -- more than 10 percent of the catch.[48]
>
> Lobster processing waste consists of shells, unextractable meat, and viscera. Amounts vary from year to year, depending upon the product mix (i.e. more lobsters shipped live or packed in brine means less waste than in a year when more lobsters are canned or processed for meat extraction).[49]

The most common traditional application of lobster waste is as a soil amendment.[50] There exists a fairly loose, non-monetary, arrangement between processors and landowners for the disposal of lobster wastes.[51] This is yet another example of a traditional informal disposal method which effectively utilises waste but brings no financial advantage.

There is now at least one proposal under consideration for processing lobster (as well as snow and rock crab) shell waste. Shellfish shells can be processed for isolation of the polysaccharide chitin and its derivative chitosan. Among the more than fifty uses for this substance are applications as a flocculent in industrial waste treatment and in health care. Shellfish shells are the sole source for the product[52], which has traditionally been produced only in Japan.[53] There

has been some study of, and limited attempts at marketing, chitin derivatives in the Maritimes in the past.[54]

FISH WASTE

There is no fish waste processing on Prince Edward Island at this time. There was a plant in Souris which produced fish meal and fish oil from groundfish, herring, and mackerel waste. This plant was destroyed in the Usen Fisheries fire of 1993. Fish waste was commonly used for fox feed on fur farms, as pet food, or bait.

This system was generally satisfactory, except during periods of peak landings, when there was often more waste than could be processed (for instance during the autumn peak in the herring fishery; herring fished for roe produce about 95 percent by-product).[55]

The Souris fish waste processing operation has never been replaced. The impact of the loss was lessened by the collapse of groundfish stocks, which sharply reduced the amount of fish waste produced throughout the Atlantic provinces.[56] As well, the herring fishery utilises more of the body than in the past, when the roe fishery produced vast amounts of waste.[57] Atlantic herring roe has traditionally been a lower value product than that from the Pacific, although the Food Technology Centre has investigated a process for the curing of roe to create a higher value produce (most Atlantic roe is processed into a sauce or spread).[58]

Like lobster waste, other fish waste has applicability as a soil amendment; the main obstacle is odour, which can be avoided by composting or the production of fish silage (which has a number of uses as both plant and animal food).

Fish waste has probably received more study than any other aspect of this report, but much of this research is only of limited relevance to Prince Edward Island. Even at the best of times, the Island's place in the Atlantic fin fishery was small by comparison with the other Atlantic provinces. This is clear from an examination of the volumes of fish landed in the region in 1991, just before the collapse.

TABLE 3

ATLANTIC FISH LANDINGS, 1991[59]

PROVINCE	GROUNDFISH*	PELAGICS	SHELLFISH
Newfoundland	269.7	104.1	48.8
P.E.I.	19.2	11.7	18
Nova Scotia	283.4	104.5	108.6
New Brunswick	14.3	76.6	24.9

***** Thousand Tonnes

The Island fishery has become varied and more highly valued in the last decade, and is valued at about $100 million annually, of which lobster represents well over half.

MUSSEL AND OYSTER WASTE

Mussel culture has become a significant fishery on Prince Edward Island, with a 1993 harvest of over 4700 tonnes worth almost $5 million. By 1995, this increased to 7469 tonnes worth about $8.6 million.[60] This has meant a growing accumulation of bottom mud, broken and undersized mussels, and bysus threads. Using Pinsent's estimate of about 475 tonnes per year of mussel waste early in the decade (c. 1990), one can estimate that about 1300 tonnes are now being produced (c. 1995).[61]

Mussel mud has a long tradition as a soil amendment on Prince Edward Island, although the market now is not strong.[62] Mussel mud consists of mud dug from mussel and oyster beds littered with shell waste.

Oysters are the other major component of Island aquaculture, with 1995 production of 1792 tonnes worth about $3.2 million, up from 1993 totals of 1205 tonnes worth $2.2 million.[63] There is a considerable accumulation of unused oyster shell on the bottom of Malpeque Bay; according to the Executive Director of the Food Technology Centre, oyster shell can be used in the production of chicken feed. The Canadian supply now comes from Chesapeake Bay.[64]

CONCLUSION

The issue of fish waste utilisation is tightly bound up with that of increasing the value of the resource and capitalising on underutilised species. The provincial government has recognised this need by establishing the Aquaculture and Fisheries Research Initiative Inc., which will "cost-share research projects in aquaculture, lobster health and processing which have direct application to Prince Edward Island."[65] The Initiative is a useful model for the entire primary resource sector. The fishing industry cannot hope for constantly increasing catches, and thus must make the best possible use of the available resource.

IV

IV A NOTE ON DOMESTIC WASTE

The domestic waste handling system on Prince Edward Island is being overhauled. The Waste Watch system, on the pattern of the operating in East Prince, will eventually cover the entire Island. Waste Watch will source-separate compostables and recyclables from waste for landfill. Recyclable material, wherever possible, is shipped for reprocessing (often to the mainland), while the compost is usually sold locally. The Wellington facility has been quite successful in substantially reducing non-reusable waste. Eventually, two landfills will serve the entire Island, as Waste Watch has been successful in reducing non-reusable material to about 35 percent of total waste (about 31 percent is compostable, the remainder recyclable).[66]

CONCLUSION : A FACILITATING STRUCTURE ?

THE PROBLEM

Simply put, too much waste with a potential for utilisation is allowed to disappear into a proverbial economic black hole. This is not to suggest that present uses are a complete loss, but that potential economic benefit is being lost for want of a structure to gather the knowledge and make the connections necessary to obtain greater value from primary resource industry waste.

A fundamental difficulty with any attempt to extract value from the waste produced by the primary resource industries of Prince Edward Island lies in the fact that there is no agency charged with seeking out opportunities and connections for the utilisation of agricultural, fisheries, and forestry waste. No one has primary responsibility for investigating this matter. Producers and most processors simply do not have time or resources to pursue these opportunities to their greatest extent.

More generally, there is a lack of public understanding that waste utilisation can go beyond simple disposal. It does not seem to be widely believed that by-products and waste can be turned to any economic advantage. The most common view seems to be that waste is a purely environmental issue, with the economic aspect restricted to the costs of disposal.

Another significant problem is a lack of connections between Prince Edward Island and other jurisdictions facing similar problems of dependence upon a limited supply of natural resources. Most of the jurisdictions of the North-Western Atlantic, from Norway to the American Eastern seaboard, face the problem of creating a sustainable and expanding economy largely based on natural resources. It might be useful for such states to create stronger links for sharing information and developing trade, as well as creating a forum for co-operative resource management (e.g. so that conflicts between neighbouring jurisdictions over straddling fish stocks may be avoided). Such links might also lead to more profitable and effective waste utilisation. For instance, might there be opportunities to "export knowledge" in connection with waste management and utilisation systems? The North Atlantic Islands Programme may provide an initial forum for such links.

A SUGGESTION

If greater value is to be derived from waste which is currently un- or underutilised, someone must be in a position to identify opportunities and potential markets. Some sort of facilitating structure must make connections between sources of waste and potential markets and users. Such an entity would focus as well on future developments in marine and agri-food industries, and on developments and potential markets in specific areas, such as:

- fish and agri-food processing waste;
- farm waste and culls;
- underutilised marine species and by-catch; and
- product quality maintenance and improvement.

Such a structure fits well with the push for an economy of finesse rather than sheer effort -- that is, an orientation to the selling of knowledge and expertise derived from primary resource industries, as an alternative to simply trying to extract more and more production from a limited resource. The latter is the traditional approach to natural resource management and exploitation;

its effectiveness is amply demonstrated by the state of Canada's fisheries and the sorry state of Prince Edward Island soil as a result of intensive farming practices.

There are entities in existence which suggest some of the functions of an agency for waste utilisation. The P.E.I. Food Technology Centre has done extensive research into many of the areas touched on in this report, particularly the increasing of product value and the search for new products (for instance, processed potato products which can be made from culls).

The agency or body in question need not be large (or expensive). Essentially, it needs a mandate to investigate possibilities for more effective waste utilisation from both the marketing and the technical aspects. It could function in association with already extant structures (e.g. the Food Technology Centre). It should have associations with government and industry, without being simply a marketing agency or a government grant generating agency.

Such a project would serve as one aspect of an attempt to add value and sustainability to resource economies.

ENDNOTES

1. *The Primary Resource Sector in the Prince Edward Island Economy* (Prepared by Agriculture Division, Statistics Canada for the Prince Edward Island Department of Agriculture, Fisheries and Forestry, January, 1997) pp. 5-7.

2. Darrell Greer, "Agricultural Exports in Hot Demand," *Guardian*: *Agriculture Issue '96* (9 April 1996) p. 8.

3. Morley Pinsent, *An Inventory of Usable Waste Products for Prince Edward Island Farms* (Prince Edward Island Department of Agriculture, March, 1991) p. 12. Hereafter cited as *Inventory*.

4. *Ibid.*; *1996 Agricultural Statistics (Vol. 30)* (Prince Edward Island Department of Agriculture and Forestry, 1997) Table 36.

5. *Report of the Royal Commission on the Prince Edward Island Potato Industry* (Ottawa, 1987) p. 9.

6. *Inventory*, p. 13.

7. Percentages calculated from figures in *1996 Agricultural Statistics (Vol. 30)* (Prince Edward Island Department of Agriculture and Forestry, 1997) Table 36.

8. Shane Murphy (Beef Specialist, Agriculture Canada Research Station, Charlottetown, 11 June 1997); Paul Blacquiere, "Beef industry struggling," *Island Harvest* (July, 1996) p. 14.

9. Gordon Catt, "Incentive program to help eliminate surplus," *Farm Focus* (June 11, 1997) p. 3.

10. Peter Boswall (Potato Specialist, Agriculture Canada Research Station, Charlottetown, 11 June 1997); 1997 Potato Information Package (P.E.I. Departmen tof Agriculture and Forestry) pp. 4-6, 8.

11. On details about the dehydration plant, see the *Eastern Graphic* (July 9, 1997) p. 3, and the *Guardian* (July 8, 1997) p. A2.

12. Peter Boswall, 11 June 1997.

13. Katherine Clough (Department of Agriculture and Forestry, Charlottetown, 22 May 1997); Wayne MacKinnon (Department of Agriculture and Forestry, 30 June 1997).

14. *Prince Edward Island Food Technology Centre Annual Report 1993*, p. 5; 1994, p. 6.

15. See, for instance, Wayne MacKinnon and Elinor Vass, *The Best of the Past: Traditional Sustainable Agriculture in Prince Edward Island* (P.E.I. Department of Agriculture/Institute of Island Studies, March, 1989) pp. 7-9.

16. Roger Henry, "Canadian Potato Farmers Get Help From Compost," *Biocycle* 34(8) 1993, pp. 70-71.

17. *Inventory*, pp. 4-9.

18. Figures from *1996 Agricultural Statistics (Vol. 30)* (Prince Edward Island Department of Agriculture and Forestry, 1997) Tables 16-17.

19. Paul Blacquiere, "Record returns and costs," *Island Harvest* (June, 1996) p. 9.

20. Lisa Mossey, "New wetland treats waste," *Island Harvest* (November, 1996).

21. *Cultivating Island Solutions: Interim Report of the Round Table on Resource Land Use and Stewardship* (Fall, 1996) pp. 10-11.

22. Teresa Mellish (Planning Officer, Agriculture Division, Department of Agriculture and Forestry) 15 July 1997.

23. *Ibid.*

24. Angus Environmental Limited, *Nova Scotia Compost Products Development Strategy* (January, 1994) pp. 30, 32.

25. Ron Sampson (P.E.I. Mussel Mud/Agriculture Canada Research Station) 12 June 1997.

26. Don Jardine (P.E.I. Director of Environmental Resources) 11 August 1997.

27. Sherman D. Nelson, Henri Dinel, and Terry Goodyear, eds., *A Program to Assess the Impacts and Benefits of Composted Source-Separated Solid Wastes (CSSSW) Applied to Agricultural Lands: National Agricultural Compost Trial* (Agriculture and Agri-Food Canada, 1995) pp. 80-81.

28. *Ibid*, p. 1.

29. Richard Ablett (Executive Director, P.E.I. Food Technology Centre) 3 July 1997.

30. One study has looked into the potential of composting hog carcasses -- particularly important in view of the growth trend in the hog industry. See Teresa Mellish and Jane Palmer, "Composting of Swine Carcasses: Turning a Problem into an Asset" (P.E.I. Department of Agriculture, Fisheries and Forestry, October, 1996).

31. Jacques Whitford Environment Limited, *Solid Waste Disposal Aspects of the Proposed Expansion of Potato Processing Facility* (Revised 29 November 1994) p. 17.

32. Richard Ablett, 3 July 1997.

33. *The Primary Resource Sector* , p. 5, 15-16.

34. *Inventory*, pp. 35-38.

35. Wayne MacKinnon (P.E.I. Department of Agriculture and Forestry) 30 June 1997.

36. Don Jardine, 11 August 1997.

37. *National Environment Strategy for Agriculture and Agri-Food* (Agriculture and Agri-Food Canada, August, 1995) p. 23; *Atlantic Environmental Farm Plan Workbook* (Atlantic Farmers Council).

38. Teresa Mellish, 15 July 1997.

39. *The Primary Resource Sector* , p. 7, 102-106.

40. *The Primary Resource Sector in the Prince Edward Island Economy*, pp. 80-81.

41. *Ibid.*, p. 38.

42. *Guardian: The Fishery and Aquaculture* (25 March 1997) p. 8.

43. Lewis Creed (Director of Fisheries and Aquaculture, Department of Fisheries and Environment) 22 May and 14 July 1997.

44. At the University of Prince Edward Island.

45. "Lobster production, health management program," *Sou'wester* (1 December 1996) p. 19.

46. *Prince Edward Island Food Technology Centre Annual Report* 1993, p. 7.

47. Richard Ablett, 3 July 1997; Darrell Greer, "Many fisheries industry improvements come through Food Technology Centre," *Guardian: Fisheries '96* (26 March 1996) p. 2.

48. *Island Harvest* (March, 1997) p. 2; (April, 1997) p. 3.

49. Lewis Creed, 14 July 1997.

50. MacKinnon and Vass, p. 8.

51. *Inventory*, p. 44.

52. Richard Ablett, 3 July 1997.

53. Lewis Creed, 22 May 1997. For detailed information on Chitin/Chitosan, see W.G. Tidmarsh, et. al., *Fish Waste Disposal Practices and Options for Eastern New Brunswick* (Department of Fisheries and Oceans, December, 1986) pp. 40, 42, 44.

54. Canadian Fishery Consultants Limited, *Utilization of Fish Wastes: An Assessment for Canada* (Halifax, March, 1991) pp. 44-45.

55. *Inventory*, pp. 41-43.

56. Lewis Creed, 22 May 1997.

57. Eric McCarthy, "Herring nets good price," *Island Harvest* (October, 1996) p. 10.

58. Darrell Greer, "Many fisheries industry improvements come through Food Technology Centre," *Guardian: Fisheries '96* (26 March 1996) p. 2.

59. Source: *Charting a New Course: Towards the Fishery of the Future* (Task Force on Incomes and Adjustment in the Atlantic Fishery, November, 1993) pp. 126-129.

60. *The Primary Resource Sector* , p. 37.

61. *Inventory*, p. 44.

62. Ron Sampson, 12 June 1997.

63. *The Primary Resource Sector* , p. 37.

64. Richard Ablett, 3 July 1997.

65. Kevin MacAdam (Minister of Fisheries and Environment), "Research initiative important key," *Island Harvest* (January, 1997) p. 8.

66. Don Jardine, 11 August 1997.

VI ANNOTATED BIBLIOGRAPHY

LOCATION AND ABBREVIATION KEY

CIRFAS: Canadian Industry Report of Fisheries and Aquatic Sciences

Confed: Confederation Centre Public Library, Charlottetown

DFO: Department of Fisheries and Oceans

Gov Docs: Government Documents

HFX City: Halifax City Regional Library, Main Branch, Halifax, Nova Scotia

Killam: Killam Library, Dalhousie University, Halifax, Nova Scotia

Robertson: Robertson Library, University of Prince Edward Island, Charlottetown

I GENERAL

Loehr, Raymond C. *Agricultural Waste Management: Problems, Processes, and Approaches*. New York and London: Academic Press, 1974.

Robertson: TD 930. L63.

A useful, if somewhat dated, introduction to issues related to agricultural waste management. See especially Chapter 9, "Utilisation of Agricultural Waste," pp. 335-352.

Mantell, C.L. *Solid Wastes: Origin, Collection, Processing, and Disposal*. New York: John Wiley and Sons, 1975.

Robertson: TD 897 .M36.

Another survey, with an extensive discussion of potential uses for waste. Like Loehr's book, rather dated.

National Environment Strategy for Agriculture and Agri-Food. Agriculture and Agri-Food Canada, August, 1995.

Robertson (Gov Docs): A22-158/1995.

See pp. 11-25 on waste and animal manure.

II PRINCE EDWARD ISLAND -- NATURAL RESOURCE INDUSTRIES (AND RELATED TOPICS)

Acton, D.F., and L.J. Gregorich, eds. *The Health of Our Soils: Toward sustainable agriculture in Canada*. Agriculture and Agri-Food Canada, 1995.

Robertson (Gov Docs): A53-1906/1995.

See particularly pp. 58-60 (soil conditions on P.E.I. and practices for improving soil structure), and p. 116 (aspects of soil health in the Atlantic provinces).

Angus Environmental Limited. *Nova Scotia Compost Products Development Strategy* (January, 1994).

HFX City: REF 631.875 N935.

Comprehensive consideration of compost potential. See especially pp. 29-33 ("Markets For Finished Compost").

Canada animal manure management guide. Agriculture Canada, 1979.

Robertson (Gov Docs): A53-1534/1979.

Considers aspects of storage, handling, and processing (including composting, p. 34). Concludes that composting is relatively labour intensive and has a limited market.

Canada animal waste management guide. Agriculture Canada, 1974.

Robertson (Gov Docs): A63-1534/1974.

Emphasizes importance of integrated animal and crop production practices to ensure manure remains a resource, rather than a pollution problem.

Cultivating Island Solutions: Interim Report of the Round Table on Resource Land Use and Stewardship. Fall, 1996.

MacKinnon, Wayne, and Elinor Vass. *The Best of the Past: Traditional Sustainable Agriculture in Prince Edward Island*. Prepared for Prince Edward Island Department of Agriculture/Institute of Island Studies. March, 1989.

Provides historical context for current concerns about sustainability and specialisation in Island farming.

Methane Gas Production From Animal Wastes. Agriculture Canada, 1977.

Robertson (Gov Docs): A63-1528/1977.

Problems and progress in research on production of methane gas from animal manure as an energy source.

Nelson, Sherman D., Henri Dinel, and Terry Goodyear, eds. *A Program to Assess the Impacts and Benefits of Composted Source-Separated Solid Wastes (CSSSW) Applied to Agricultural Lands: National Agricultural Compost Trial*. Agriculture and Agri-Food Canada, 1995.

Robertson (Gov Docs): A54-8/1995-9.

See especially pp. 6-7, 81 (interest and trials on Prince Edward Island and in Eastern Canada).

Pinsent, Morley E. *An Inventory of Usable Waste Products for Prince Edward Island Farms*. Prepared for the Prince Edward Island Department of Agriculture, Charlottetown, March, 1991.

Confed (PEI Collection): 630 PIN 920;

Robertson (PEI Collection): TD 794.5 .P56 1991.

The most valuable reference work for waste on Prince Edward Island. Deals with all industries, as well as municipal sewage, etc. Particularly strong on potato industry, slightly dated on the fishery. Pinsent's report is a comprehensive inventory and overview.

The Primary Resource Sector in the Prince Edward Island Economy. Prepared by Agriculture Division, Statistics Canada, for the Prince Edward Island Department of Agriculture, Fisheries and Forestry, January, 1997.

A comprehensive and up-to-date overview of the place of the primary resource sector in the provincial economy. Essential for study of any topic related to agriculture or the fishery.

III THE POTATO INDUSTRY AND POTATO WASTE

Beef Production in the Atlantic Provinces.

Robertson (Gov Docs): A63-1494/1983.

See pp. 17-18 on feeding of cull potatoes to cattle.

Burton, W.G. *The Potato: A Survey of its History and of Factors Influencing its Yield, Nutritive Value, Quality and Storage*. Wageningen, Holland: H. Veenman and Zonen N.V., 1966. Second edition.

Robertson: SB 211 .P8 B88 1967.

See pp. 302-305, "Uses of the Potato other than for human consumption."

Cargill, B.F., ed. *Engineering for Potatoes*. Michigan State University/American Society of Agricultural Engineers, 1986.

Robertson: SB 211 .P8 E53 1986.

Glendinning, Donald. *Report on the Impact of Technology on the Potato Industry in Prince Edward Island*. November, 1988.

Robertson (PEI Collection): PEI HD9235.P82 G54.

This decade-old report identifies many of the problems which face the Prince Edward Island potato industry: growing size and specialisation of farming, threats to the soil from erosion and chemicals, and concerns about quality control and product value.

Guidelines for Feeding Potato Processing Wastes and Culls to Cattle. Agriculture Canada, 1974.

Robertson (Gov Docs): A53-1527/1974.

Deals with nutrition and handling of potato waste, as well as possible problems -- choking, toxins and pesticides, etc. Also summarises potato feeding trials.

Jacques Whitford Environment Limited. *Solid Waste Disposal Aspects of the Proposed Expansion of Potato Processing Facility*. Prepared for Cavendish Farms, New Annan, P.E.I. Revised November 29, 1994.

Robertson (PEI Collection): PEI TD 195 .F47 J33 1994.

Provides useful information about quantity of waste produced at Prince Edward Island's largest french fry plant.

P.E.I. Potato Industry Action Plan: A Blueprint for Our Future (Draft for Consideration). P.E.I. Potato Board, etc., March 23, 1994.

Robertson (PEI Collection): HD9235 .P82 P7 1994.

This plan called for an industry-wide perspective for the producing and marketing of potatoes, recognising the need to add value to the product and to open and maintain new markets. As such, it provides a framework into which the profitable utilisation of potato industry waste can fit.

Report of the Royal Commission on the Prince Edward Island Potato Industry. 1987.

Confed (PEI Collection): 633.4 DRI.

Stevenson and Kellogg. *Study of Feasibility of Dehydrated Potato Processing on P.E.I.* 1962.

Robertson: PEI-Microfiche No. 2004.

Stevenson, Kellogg, Ernst and Whinney. *Summary of Report Findings: Feasibility study re dehydrating potatoes on Prince Edward Island*. Prepared for Prince Edward Island Department of Industry, Charlottetown, P.E.I., 1987. 6 pp.

Robertson (PEI Collection): PEI-Agriculture-Potatoes-Vertical File.

With the announcement of a potato dehydration plant to be built in Souris, this report, a follow-up to the 1962 study, is topical. It provides a useful, if somewhat dated (especially regarding Eastern Europe), consideration of markets for dehydrated potato products. This is a short summary; the full report was not released to the public.

IV THE FISHERY AND FISH/SHELLFISH WASTE

a General

Canadian Fishery Consultants Limited. *Utilisation of Fish Wastes: An Assessment for Canada*. Prepared for Industry, Science and Technology Canada, Halifax, N.S., March, 1991.

HFX City: Ref 639.2 U89 c.1.

Along with Tidmarsh, et. al. (1986), this is the most comprehensive consideration of applications of fish waste. The most detailed work available from a specifically Canadian perspective, although relatively weak on shellfish waste utilisation.

Gillis, Carolyn A., M.SC. *Aquaculture and the Export of Knowledge-based Services*. The North Atlantic Islands Programme/The Institute of Island Studies, May, 1996.

Global Market Opportunities Report: Lobster. Sectoral Liaison Secretariat, Department of Foreign Affairs and International Trade, April, 1995.

Killam (Gov Docs): 2FG E 73-10 1-3 1995 DOC+.

Robertson (Gov Docs): E73-10/5-1993.

Global Market Opportunities Review: Non-Traditional Species Fish. Sectoral Advisory Secretariat (TOS), International Business Development Branch, External Affairs and International Trade Canada. August, 1993.

Killam (Gov Docs): 2FG E 73-10 5 1993 DOC+.

Robertson (Gov Docs): E73-10/5-1993.

These reports on world market opportunities are selections from a series of assessments of the world market for fish products issued by the Department of Foreign Affairs and International Trade.

James, D.G., "Marine Living Resources: Present utilisation and future," in Reinertsen, Helge and Herborg Haaland, eds. *Sustainable Fish Farming*. Rotterdam/Brookfield: A.A. Balkema, 1995, pp. 25-42.

Robertson: SH 328 .I68 1994.

A useful global perspective on marine resources and the use of fish waste in production of aquaculture fish feed.

Martin, A.M., ed. *Fisheries Processing: Biotechnological Applications*. London: Chapman and Hall, 1994.

Robertson: SH 334.7 .F57 1994.

Includes articles on chitin/chitosan (pp. 155-173), crustacean wastes (pp. 174-205), silage (pp. 244-272), and mussel processing wastes (pp. 311-343).

Nowak, W.S.W. *The Lobster* (Homaridae) *and the Lobster Fisheries: An Interdisciplinary Bibliography* (St. John's: Memorial University, 1972).

Robertson: Ref Z 5973 .L62 N69.

Comprehensive but dated.

Schmidtsdorff, Walther, "Fish Meal and Fish Oil -- Not Only By-Products," in A. Ruiter, ed., *Fish and Fishery Products: Composition, Nutritive Properties and Stability* (CAB International, 1995) pp. 347-376.

Robertson: SH 335 .F6284 1995.

Standing Senate Committee on Fisheries. *The Marketing of Fish in Canada, Report on the East Coast Fisheries (Interim Report III)*. December, 1989.

Robertson (Gov Docs): YC 25-342/1-4.

A useful summary of some potential applications of fish waste. See pp. 84-85, 94-97.

Tidmarsh, W.G., J.H. Merritt, G. Bernier, J. Joza, and S. Bastien-Daigle. *Fish Waste Disposal Practices and Options for Eastern New Brunswick: CIRFAS No. 176*. Moncton: DFO, December, 1986.

Robertson (Gov Docs): Fs97-14/176.

Despite the age of the report and specificity to New Brunswick, the problems considered here are similar to those facing Prince Edward Island. The New Brunswick and Prince Edward Island fisheries are very similar. Detailed consideration of potential products and markets for finfish and shellfish waste.

b Specialised Studies

There is a massive quantity of technical literature on Canadian fisheries, issued under the auspices of the Department of Fisheries and Oceans. The studies cited here are chiefly concerned with fishery wastes and underutilised species.

Atlantic Fisheries Development: Fish Silage Workshop, Church Point, N.S., June 17, 1987. DFO, 1987.

Robertson (Gov Docs): Fs68-2/1-7.

A useful overview of fish silage research and development in the Atlantic provinces. See especially p. 84, "A Project with Fish Silage as Hog Feed on Prince Edward Island."

Atlantic Fisheries Development: Surimi Development Workshop, Clarenville, NFLD: Proceedings, January 28-30, 1987. DFO, 1987.

Robertson (Gov Docs): Fs68-2/1-4.

See especially pp. 70-71 ("Overview of Fish Waste Utilisation Programs") and p. 84 ("Fish Silage as Hog Feed on Prince Edward Island").

The proceedings of a conference intended to explore technology transfer and research and development for future initiatives in the field of surimi. The best introduction to surimi issues in a specifically Atlantic Canadian context.

Canpolar Inc. *A Trial to Establish Technical and Commercial Viability of Cod Frame Mince Recovery. CIRFAS No. 197*. St. John's: DFO, December, 1988.

Robertson (Gov Docs): Fs97-14/197.

Trials of technology which "has shown the potential to increase the productivity of an Atlantic Region fish plant from 5 % to 15 % by utilizing mince derived from cod waste as edible portions and for surimi feedstock." (p. 1).

Canpolar Inc. *Development of Process Controls for Surimi Production, Parts I and II. CIRFAS No. 192 and 192B*. St. John's: DFO, March, 1988.

Robertson (Gov Docs): Fs97-14/192, Fs97-14/192B.

A study of surimi-processing with a view to developing "process controls" in order to allow plants to adapt to a variable mix of underutilised species and waste material from other fish processing operations (e.g. cod frames).

Chandra, Chinniah. *Production and Quality Assessment of Surimi from Selected Atlantic Groundfish and Male Capelin. CIRFAS No. 190.* St. John's: DFO, March, 1988.

Robertson (Gov Docs): Fs97-14/190.

Findings suggest that good quality surimi can be produced from cod, capelin, or a mix of the two, while trawler cod mixed with flounder frames can also produce an acceptable quality surimi.

Gendron, Louise and Shawn Robinson, eds. *The Development of Underutilised Invertebrate Fisheries in Eastern Canada. Workshop Proceedings, Moncton, NB, November 23-25, 1993. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2247*. DFO, 1994.

Robertson (Gov Docs): Fs94-4/2247.

This workshop concluded that there is a lack of biological information on which to base a fishery management plan for underutilised species. Such a lack of information about an almost untouched high-value resource could jeopardise proper development. The discussion called for a rational management plan.

Kreiberg, H., J.R. Brett, A. Solnie and R.A. Carter. *A Handbook on Impounding Sac-Roe Herring. CIRFAS No. 168*. Nanaimo, B.C.: DFO, March, 1986.

Robertson (Gov Docs): Fs97-14/168.

Impounded herring will delay spawning, while roe yield and quality remain high. (This is one of several reports originating on the Pacific Coast which may not apply in all respects to the Atlantic fishery. On differences between Atlantic and Pacific herring, see Eric McCarthy, "Herring nets good price," *Island Harvest* (October, 1996) p. 10.)

Miller, R.J., and R.E. Duggan. *Trap Design for a Directed Rock Crab Fishery. Canadian Technical Report of Fisheries and Aquatic Sciences 2154*. Halifax: DFO, 1997.

Robertson (Gov Docs): Fs97-6/2154.

Study into a trap design to minimize by-catch of lobsters in the new experimental rock crab fishery (which only came under regulation in 1995).

Sloan, N.A., and C.R. Gunn. *Fishing, Processing and Marketing of the Jellyfish*, (Aurelia aurita) (L.), *from Southern British Columbia. CIRFAS No. 157*. Nanaimo, B.C.: DFO, June, 1985.

Robertson (Gov Docs): Fs97-14/157.

Jellyfish yields a low quality dehydrated product, which failed to interest target consumers. There does not appear to be a chance for a viable fishery. Note also that this report originated in British Columbia, and not all conditions apply equally to the Atlantic Coast.

A Study of the Use of Cod, Cod By-Products and Crustacean By-Products for Surimi and Surimi-Based Products. CIRFAS No. 177. St. John's: DFO, October, 1986.

Robertson (Gov Docs): Fs97-14/177-1 (Part I); Fs97-14/177-2 (Part II); Fs97-14/177-3 (Part III).

Chinniah Chandra. *Part I: Raw Material Assessment*.

N. Haard. *Part II: Physiology Studies*.

M.N. Voigt. *Part III: Shellfish Flavour Extraction Studies*.

Parts I and II focus on cod; Part III on crabs and scallops.

Ward, W.J., G.A. Parrott and D.G. Iredale. *Fish Waste as Silage for Use as an Animal Feed Supplement. CIRFAS No. 158*. Winnipeg: DFO, August, 1985.

Robertson (Gov Docs): Fs97-14/158.

Concludes that, despite relatively high costs, with suitable feeding systems the demand for fish silage supplement could increase. The bulkiness of the products suggests that production should be located close to a market; but silage is attractive for its high protein quality and low energy requirements.